RECONCILING GAMEBIRD HUNTING AND BIODIVERSITY (REGHAB)

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Management tools for reconciling bird hunting and biodiversity.

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1- INTRODUCTION

Previous work-packages have reviewed socio-economic aspects of hunting (WP 1), potential benefits for conservation of biodiversity (WP 2) and problems for biodiversity (WP 3).

In recent years, much social pressure has developed against hunting. The historical practice of banning hunting save for the aristocracy often changed in young European democracies to a free-for-all in which game species (especially deer) and predators were extirpated over large areas (WP 1). In Britain and other European countries, the aristocracy had also protected raptors for use in falconry (Cooper 1979), yet later predation on game and livestock motivated extirpation of raptors, often supported by bounty payments (Newton 1979). Reaction to these "tragedies of the commons" (Hardin 1968) and to the original privileged status of hunting, accompanied by anthropomorphic and romantic views of "nature" in urbanised societies (Wilson 1984, Taylor 1986), have resulted in antipathetic attitudes to hunting.

That early tradition of conservation by a knowledgeable and powerful minority has gradually re-established within democracies, but in this case (appropriately) as a plurality. On the one hand are the hunters, often associated with land-owning or other aspects of social status, who have promoted study and conservation of game, typically with mostly unmeasured benefits for biodiversity (WP 2). On the other hand are the protectionists, who have benefited biodiversity primarily by promoting legislation that helps to change attitudes and by creating reserves. Through the success of powerful protection organisations, the paradigm for conservation in Europe has become "protect and reserve".

At national and even regional level in Europe, the threat of deliberately driving predators to extinction now seems small, although problems remain at local level for avian predators (WP 3). The best documented case is that of the hen harrier (*Circus cyaneus*) on grouse moors in Scotland (see also WP 5). There also appear to be problems with raptors being poisoned, perhaps often with baits intended for other species, at local and possibly regional level in several European countries, particularly in the Iberian Peninsula (WP 3).

How has the "protect and reserve" paradigm benefited biodiversity as a whole? Let us use a very simple view of biodiversity, as species-richness. The richness may be measured at continental and national scales, in which case biodiversity loss through extinction has not been great recently in Europe; some countries have even gained species, through reintroduction and recolonisation (as well as less-desirable colonisation by exotics). However, effects at the local level tend to be much more severe, greatly underestimating extinction rates at scales relevant to local communities (Thomas & Abery 1995).

This raises an interesting hypothesis, that if people lack biodiversity to appreciate at local level, they may eventually lose interest in preserving it altogether (Kenward & García Cidad 2002). For scientists, conflicts about hunting and the testing of hypotheses are bread and butter. However, hunters, other conservationists and those in general who appreciate biodiversity will not wish to see this hypothesis tested. Therefore the challenge now in Europe is not merely to maintain biodiversity at national level, but to enhance it again at local level. We need to move forward from outdated attitudes, but remain informed by them. We need to see opportunity in the widespread nature of the hunting resource (WP1), whose strength lies in its often unrealised potential for conservation (WP2) but can also sometimes present threats (WP3). We need to avoid the conflicts and seek ways for biodiversity to benefit maximally from bird hunting, by enhancing the benefits while minimising the threats.

This work-package considers the required optimisation process and management tools. It first examines the threats in more detail, drawing on new data and previous work-packages to assess which problems appear most serious. The second part presents and reviews the value of current and possible future tools for management. These are management tools not only for solving predation problems in the field, but also sociological and economic tools for optimising use of human resources for conservation through sustainable use. In order to maintain contact with the context, the work-package moves in each section from the general view to the detail. It closes with recommendations.

2- THREATS TO BIODIVERSITY

Previous work-packages have revealed four associated categories of threat to biodiversity in Europe that involve hunting. These are:
1. Unwittingly driving huntable birds to extinction
2. Deliberately driving predators to extinction
3. Unwittingly threatening predator populations
4. Stopping hunting that preserves habitats

2.1- Threats to huntable species

Threats are factors that reduce biodiversity by causing extinction of species. Of the four threats mentioned above, the threat of unwittingly driving huntable bird species to extinction must now be small in Europe, whether at national or local level, due to education of hunters, regulations and the vigilance of other conservationists. There seem to be no recent cases of extinction due primarily to hunting in Europe, whereas declines of many bird populations are attributed to intensified land use (e.g. Krebs et al. 1999).

A second, and perhaps now more important risk than overhunting, is damage to wild populations from disease or from dilution of a locally best-adapted gene-pool by extensive releases. There is now some evidence for such effects, considered effectively in WP3. The irony here is that an intention to assist stocks may sometimes harm them (similar considerations also require great care during releases for to enhance biodiversity).

2.2- Killing of predators

Extirpation of some raptor species in Britain can be attributed to early industrialisation, which produced an increased density of humans, an increase in leisure to hunt game and a reduction of woodland habitat below 4% of the land area (Newton 1979). More recently, growth of leisure interest in raptors motivated legal protection for them, with added urgency when organochlorines were found to threaten extinction of some populations. Present emphasis is on restoring diversity of raptors to areas from which they were eliminated (Evans et al. 1994, Cade 2000), but this and the recovery of populations that were previously depressed has increased the need for solutions to predation problems. Where raptors can become abundant enough for their predation to put human livelihoods at risk (Redpath & Thirgood 1997), total protection does not prevent deliberate killing (Etheridge et al. 1996).

It is important to note that hunting is not the only human activity in which there may be conflict with raptors (Kenward et al. 1999, 2000). This is well illustrated by data kindly provided, in questionnaire responses, from national delegates to the Bern Convention and by senior hunting organisations in the same EU Member Countries and Accession States. The Bern Convention promotes and monitors protection of species and habitats in Europe, with its national delegates typically from government environment ministries. Responses were obtained from 22 of 25 states surveyed, so the data should be representative of responsible opinion.

The first question concerned the seriousness of the problem from raptors for different interests (Figure 1), and for the relationship of those interests with the government organisation. Possible scores were from 0 (= no problem) to 5 (= extreme problem). In general, problems were perceived by governments and hunters as least for keepers of livestock and poultry, and worst for pigeon keepers and game interests. The problem for hunters were perceived as most

severe, scoring 3 in three states and 4 in one, and hunters in two states scored 4 for their problems with government on this issue. Hunters were generally more concerned than the government delegates about all raptor problems, especially the threat of raptors to non-game wildlife populations.

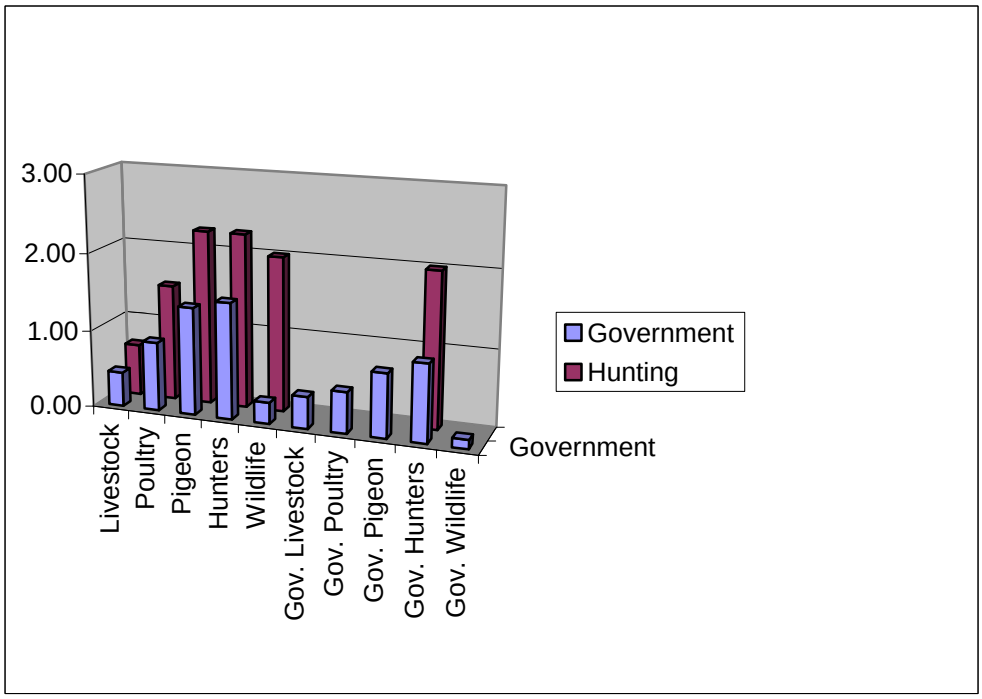

Figure 1. Perception, by government environment ministries and senior hunting organisations in the EU and Accession States, of the problems caused by raptors for different interest groups and for the relationships of those groups with the ministries, averaged on a scale of 0 (=none) to 5 (=severe).

In general, problems were perceived by governments and hunters as least for keepers of livestock and poultry, and worst for pigeon keepers and game interests. The problem for hunters were perceived as most severe, scoring 3 in three states and 4 in one, and hunters in two states scored 4 for their problems with government on this issue. Hunters were generally more concerned than the government delegates about all raptor problems, especially the threat of raptors to non-game wildlife populations.

A subsequent question concerned the species of raptors considered to cause problems (Figure 2). Again, there was quite strong agreement between government delegates and hunting organisations. In each case the goshawk (*Accipiter gentilis*) was most often cited as problematic, with the buzzard (*Buteo buteo*) second, both well ahead of the other species in the number of countries concerned. However, hen harriers and marsh harriers (*Circus aeruginosa*) were together mentioned not much less than buzzards.

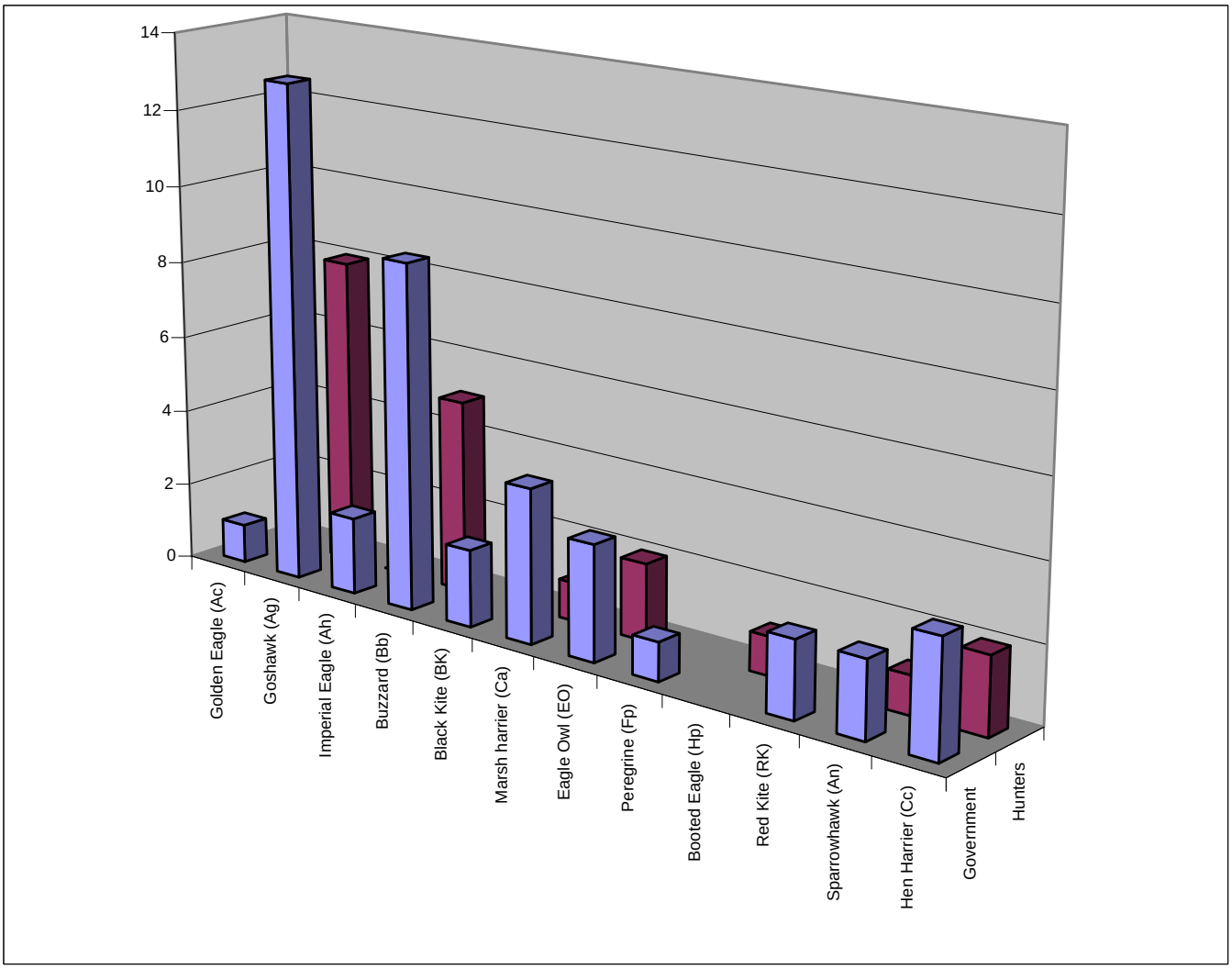

Figure 2. Numbers of government environment ministries and senior hunting organisations in EU and Accession States that named each species of raptor as the worst, or second worst, cause of problems for hunters (from ministries in 22 states and hunting organisations in 12).

A further question concerned the perceptions of government and hunting representatives of illegal killing of raptors. Scoring was again from 0, for no illegal killing expected from a particular activity, to 5 for frequent killing. The overall view was of shooting being the most frequent cause of illegal death, followed by trapping and poisoning (Figure 3). However, the illegal killing was typically considered "rare" (=1) and reached "moderate" (=3) only in the perception of one government and two hunting organisations.

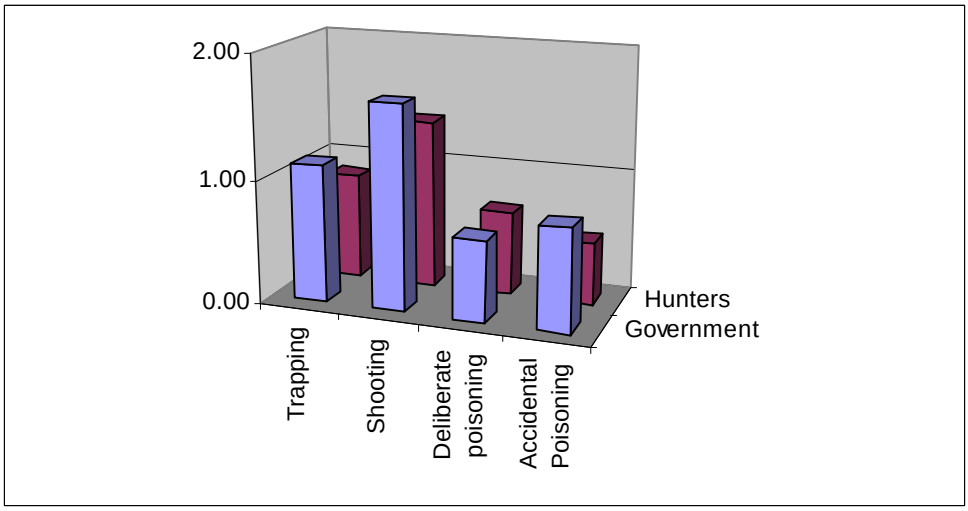

Figure 3. Perception, by government environment ministries and senior hunting organisations in the EU and Accession States, of the severity of illegal killing of raptors, averaged on a scale of 0 (=none) to 5 (=severe).

Other questions showed that only 7 of the 22 responding governments permitted killing or translocation of raptors for any purpose (although it is possible to derogate from the Bern convention and EU legislation if necessary). By way of contrast, use of wild birds for falconry (although in some cases only if obtained incapacitated from the wild) is permitted in 11 states. Most interestingly, when hunting organisations were asked what measures they would favour with a free choice, only 4 of 12 had a moderate to strong preference (scoring 3-4) for killing or translocation.

The take-home message is that although raptor predation is considered a problem by governments and hunters, and for relations between hunters and government, in most countries neither group now considers illegal killing a frequent occurrence. Where problems are recognised, it is the common species, goshawk and buzzard, that are most often cited. Perhaps the most important finding is that senior hunting organisations are not widely interested in being able to kill or translocate raptors. Europe is far from the days of general extermination policies for predators. It is important to realise this, because leaning hard on an open door can cause damage.

2.3- Loss of hunting

The best examples of biodiversity loss where hunting is forbidden by law come from southern Africa. In areas where hunting was forbidden, large mammals were lost through exclusion by fencing, or by poaching, until a value was given to the wildlife resource again by restoration of game ranching or hunting (Child 2000, Earnshaw & Emerton 2000). Ranching is also less destructive of native vegetation (and hence presumably of dependent small fauna) than the alternative of extensive farming (Hopcroft 2000). Hunting provides more income than ranching, with requirement for high game densities (Heath 2000, Leader-Williams 2000). Although eco-tourism can replace hunting in areas with good infrastructure, trophy-hunting can bring high income with less infra-structure and drain on local resources such as water (Bigalke 2000, Hurt & Ravn 2000).

In Europe, with its rapid changes in land-use, it is typically hard to distinguish cause and effect when hunting a given species is prevented. For example, was a species lost because loss of motivation to hunt preceded agricultural change, or vice versa? There is certainly evidence that game conservation can increase biodiversity (WP2), but less evidence that inability to hunt birds reduces biodiversity. For the partridge (*Perdix perdix*), habitat change has reduced populations over wide areas to levels where hunting must stop and the species may even disappear (Potts 1986), although intensive removal of predatory mammals and corvids can re-build stocks (Tapper et al. 1996).

In such a case, hunting can be stopped indirectly, by preventing removal of predators. A good example comes from the study of raptors on heather (*Calluna*) moors in Scotland (see WP5), where shooting of grouse (*Lagopus lagopus scotticus*) can become an uneconomic land-use without (illegal) removal of raptors (Thirgood & Redpath 1997, Redpath & Thirgood 1997). A viable alternative land-use is forestry; however, the grouse, their predators and other open-country species are then replaced. As grouse stocks have also declined due to increased grazing by sheep and deer, which cause heather replacement by grass, shooting might become economic again after removing grazing mammals (Thirgood et al. 2000a,b). However, removing grazers carries a cost, as does artificial feeding of breeding raptors to reduce predation on grouse (Redpath et al. 2001), with uncertain net economic benefits in the long-term relative to those from aforestation.

Of course, numbers of hunters may decline for reasons other than being banned or being rendered uneconomic by competition with predators. Hunting may become unfashionable, or be limited by examinations or other criteria. Does that matter? It would not matter if (a) hunter contributions to conservation were not needed or (b) hunting cannot contribute.

Are hunter contributions to the maintenance and restoration of biodiversity irrelevant in Europe? If we accept that maintenance and restoration are required, what are the alternative sources, and can they alone be adequate? It has been estimated that to preserve 6% of the remaining natural habitats in the world (with little in Europe) would cost 6 Billion Euros per annum, with a further 25 Billion Euros to increase that to 10% (Constanza et al. 1997). No figures exist for Europe as a whole, and they will in any case vary between individual countries. However, it is worth noting that the total annual funding for the EU Common Agricultural Policy is around 4 Billion Euros. Could even this amount be maintained as agri-environment subsidy by democratic governments faced by competing demands for security, health, education, transport, housing, etc? As it is likely that the answer to the question will be "no", IUCN's European Sustainable Use Specialist Group has recommended to the UNEP High-Level Conference on Agriculture and Biodiversity to "encourage research to develop land management that, with minimum loss of agricultural yield, would maximise both biodiversity and consequent income from sustainable use of biodiversity" (Kenward & García Cidad 2002)

The question of whether hunting can maintain or enhance biodiversity is to some extent moot. When planning for the future, the question is not "do hunters contribute", but "can they contribute?" The answer to that is clearly "yes", because if voluntary contributions are insufficient, hunting can always be obliged to contribute by taxation. Indeed, hunters are taxed for conservation purposes in some countries, as are other sustainable uses of wildlife. If there is inadequate funding for maintenance and enhancement of biodiversity from non-hunting sources, it may be better not to ask "can we avoid losing hunters" but "how can we increase the number of hunters?" Options for enhancing biodiversity by hunting are considered below, as socio-economic management tools.

3- ECOLOGICAL MANAGEMENT TOOLS

There are a wide variety of solutions available for predation problems (Kenward & Marcström 1981, Kenward et al. 1999, 2000). These include behavioural solutions, demographic (or lethal) solutions and compensation schemes. The behavioural and demographic solutions are considered in this section, leaving compensation schemes for consideration with other economic management tools. The most appropriate solution is likely to vary with whether a predation problem is localised or diffused.

A characteristic of predation problems is that damage is not distributed equally across all situations. For most raptors that can cause problems, damage occurs in some countries but not in others (Figure 2). However, even within a country, predation impacts may be severe in some cases and unimportant elsewhere (Lloyd 1975, Davies 1999). This may be because circumstances sometimes make prey unusually vulnerable to any predator, or because individual predators sometimes becomes specialist in a particular prey, and perhaps also the former reinforced by the latter. For example, surveys of buzzard predation at pens of released pheasants (*Phasianus colchicus*) showed an average take of 4%, but a distribution of kills ranging from none at many pens to more than 20% of the pheasants at a minority (Kenward et al. 2001). The pens with heavy predation had little shrub cover, much deciduous canopy that provided perches for buzzards and few pheasants relative to the size of pen. All were factors that would have increased vulnerability of prey to attack, the latter by minimising benefits of flocking. Independent tracking of radio-tagged buzzards showed that only 8% associated strongly with pheasant pens, and especially where there was much deciduous canopy to provide perches and few pheasants.

A variety of solutions, up to the level of removing problem-causing individual raptors, have been accepted in position statements and resolutions from the two main international non-government organisations that specialise in raptors, the Raptor Research Foundation and the World Working Group on Birds of Prey and Owls (e.g. WWGBP 2000). However, solutions are typically less easy when predation is diffused. Problems tend to be worst when a prey species is strongly preferred by predators, such that they do not switch from it to alternative prey at low density of the favoured prey (functional response Type II rather than Type III of Holling 1959), and may thus have a severe impact if drawn to an area by abundant alternative prey. This was the situation for goshawks taking wild pheasants in an area where rabbits (*Oryctolagus cunniculus*) were abundant (Kenward 1986). Moorland peregrine falcons had a Type II functional response to density of adult grouse, whereas the predation of hen harriers on grouse chicks was Type III (Redpath & Thirgood 1997, 1999). However, the numerical response of breeding harriers to abundance of passerines and rodents nevertheless resulted in a very high predatory impact: grouse numbers in autumn could have been 3.9 times higher without harriers (Thirgood et al. 2000c).

In examining the possible ecological solutions, it is important to remember that each needs to be effective and economically sustainable in order to be acceptable. Moreover, any demographic solutions need to be selective for minimal impact on raptors, in order to maintain biodiversity.

3.1- Behavioural solutions

At least five possible behavioural solutions are available to those suffering from raptor predation on game at release or feeding sites (Kenward & Marcström 1981). The most common are the prevention of predation by exclusion or landscaping techniques, but deterrence, distraction and pre-emption are also possible.

3.1.1- Exclusion

Excluding raptors from game-birds in rearing pens (and domestic poultry) is as old as chicken netting. Netting sides to game release pens exclude predatory mammals (Hill & Robertson 1986). However, although raptors have been excluded by netting the roof on large experimental enclosures (Krebs et al. 2001), roofed pens are much more expensive and would negate the role of pens in allowing birds to leave when they can fly well enough to clear the sides.

3.1.2- Landscaping

Landscaping can involve adding cover, as in pheasant release pens (Lloyd 1975, Kenward et al. 2001) or trees that offer hunting perches above game release pens or feeding stations (Mikkelsen 1984). The improvement of general landscapes to minimise raptor predation on game may also have promise. There are indications, for example, that partridges (*Perdix perdix*) suffer reduced raptor predation in areas with few trees (Potts 1986). Moreover, there is increase in density of hen harriers that settle to breed where a high grassland content enhances numbers of small passerines and rodents (Thirgood et al. 2000b), which suggests that predation on grouse might be reduced by reducing the grazing that encourages grass growth (Thirgood et al. 2000a).

However, landscaping may be an expensive option, and will have consequences for other aspects of biodiversity. It is also necessary to be sure that links between landscape and predation are causal. Possible problems are that when intensification removed cover, it also removed food for prey, or that improved cover might conceal predators rather than prey. Landscaping solutions are easy to suggest, but require experimental studies to show they are effective, economic and free from possible adverse impacts on other species.

3.1.3- Deterrence

Although deterrence by visual or auditory stimuli has been considered potentially useful (Galbraith et al. 2000), this approach has not shown by robust laboratory or extensive field experiments to be highly effective. However, following laboratory experiments with taste repellent chemicals on food for raptors (Brett et al. 1976, Musgrove 1996, Nicholls & Bird 2000), the application of repellent or aversive chemicals seems worth trying in the field to deter avian predators during a short period of high vulnerability, such as when game is released. On the other hand, this technique has not proved effective for countering predation by foxes (Reynolds & Tapper 1996).

3.1.4- Distraction

The classic case of distraction is the supplementary feeding of harriers on grouse moors (Redpath et al. 2001). Feeding experiments during 2 years did not increase the density of nesting harriers, but reduced the number of grouse chicks taken by fed birds to 0.5 per 100 observation hours, compared with 3.7 for un-fed harriers. However, the feeding was not followed by increased autumn density of grouse, for reasons that were unknown but which could have included attraction of other predators into the experimental area. The feeding also added 11% to management costs. Without proven effect on grouse bags, supplementary feeding is unlikely to be adopted as a practical solution for raptor predation on red grouse.

3.1.5- Pre-emption

In Sweden, where goshawk predation on wild pheasants was low until the arrival of snow-cover, it was recommended that shooting should be moved forward to late autumn from its traditional time at Christmas, not only to pre-empt the goshawk predation but to leave fewer pheasants to attract hawks into the area (Kenward & Marcström 1981).

3.1.6- Farmed game-birds

Game farming implements several of these behavioural approaches at the same time, but is also a paradox for conservation. Birds reared in captivity do not depend on good habitats for breeding, may be fed to support high densities and can be released old enough and well protected to minimise predation. At pheasant release pens in Britain, where goshawk, buzzard and fox (*Vulpes vulpes*) are the worst problems (Harradine et al. 1997), careful design can prevent serious losses from all but goshawk (Kenward et al. 2001). Goshawks are currently rare, and with hen harriers and red kites not yet abundant again after extirpation, habitat improvement might enable hunting of wild game stocks. However, if harriers impact red grouse populations at densities above 0.2/km^2, how much point would there be in habitat improvement to enhance wild breeding, if buzzard density is 2/km^2 (Kenward et al. 2000) and especially if goshawks, kites and harriers return?

3.2- Demographic solutions

When other solutions are impractical or uneconomic, there is agreement among raptor specialists in their two main international organisations that a last resort can be the removal of individual raptors that cause problems. This is also legally permitted in the European Union through derogation under the Birds Directive. Article 9 permits derogations where there is "no other satisfactory solution", on grounds of health and safety, damage, protection of flora and fauna, research and teaching, or for re-introductions.

When demographic solutions are contemplated, there may be concern that relaxation of total protection will again produce extirpation of predators. However, this fear is not supported by recent experience in countries where limited removal of problem raptors has been (see below). The probable reason is that healthy raptor populations are larger and more resilient than indicated by early population models based on ringing data

In 26 early analyses of ring recoveries from raptors, the lowest estimate of first-year mortality was 50%, and 17 were more than 60% (Newton 1979). In contrast, extensive radio tagging during the 1980s showed that goshawks on the Swedish island of Gotland had a first-year mortality of only 42%, and mortality of first-year buzzards in southern Britain was a maximum 36% in the early 1990s (Kenward et al. 1999, 2000). In each case, the proportion of deaths due to humans or impact with human artefacts was overestimated by contemporary ringing data.

On Gotland, 48% of ring recoveries were from goshawks killed by humans (which was legal to protect poultry) compared with 35% of deaths among radio-tagged hawks, and the ringing data estimated more than 60% first-year mortality. A recovery bias may also have been augmented by persecution and pesticides to generate the high first-year mortality estimates from early ringing data.

Juvenile mortalities of 42% for radio-tagged goshawks and 36% for buzzards predicted that populations in spring contained 2-4 times as many hawks as were breeding, and this was confirmed by independent tests. The data also predicted that the goshawk population could have sustained 64% first-year losses without decline in breeding population, and 76% for the buzzards (Kenward et al. 1999, 2000). Even lower first-year mortalities, of 10-29%, have been recorded in studies of radio-tagged *Haliaëtus* eagles (Buehler et al. 1991, Bowman et al. 1995, Nygård et al. 2000) and red kites (*Milvus milvus*) (Dixon 2001). Although it has long been recognised that raptor populations contain non-breeders (Newton 1979), the underestimation of juvenile survival has resulted in underestimation of non-breeder density, and hence of the ability of some raptor populations to sustain removal.

On the other hand, it cannot be assumed that raptor populations always have large non-breeding surpluses. Juveniles of some eagle species appear sometimes to gather in areas where they are at high risk due to deliberate killing or human artefacts, with severe losses of juveniles contributing to population declines (J. Vinuela, pers. comm., see also WP3). Removal should certainly never be considered without research and modelling of the relevant populations to predict its impacts.

Where removal of raptors might be the most cost-effective approach, it is also important that techniques should be selective, humane and unlikely to damage biodiversity. A number of approaches have been considered, including translocation, zoning with quotas and the co-opting of other species by encouraging intra-guild predation.

3.2.1- Translocation

Translocation is not a lethal approach, but does alter local demography by removing individuals from one area to another. It has been used widely in Sweden for goshawks, and also for eagles killing livestock in the USA (Matchett & O'Gara 1987). In Sweden, experimental translocations of ringed goshawks from many pheasant release sites showed that few returned after being moved more than 30 km (Marcström & Kenward 1981).

The capture of such birds alive was humane and ensured selection, not only of the target species but also of the problem individuals. Tests with spring nets set on pheasant kills showed that all captured birds could be released unharmed and that, unlike box traps baited with live pigeons, the spring nets caught only goshawks that were killing pheasants (Kenward et al. 1983). Moreover, the traps rarely caught hawks of breeding age, so hawks removed were primarily juveniles, which tended to accumulate in areas of high prey density after dispersal, and not the breeding adults (Marcström & Kenward 1981, Kenward et al. 1993). Permitting the setting of spring nets on kills was effectively fail-safe, because it could only be applied where there was a predation problem, and selectively removed only the minority of juvenile hawks that caused problems. A final advantage was that the live raptors were available for cooperation between different interest groups, by providing birds for reintroductions, research, education and falconry (Kenward et al. 1981).

However, translocation may not always be so convenient. For the goshawks in Sweden, short movement distances reduced costs, but may have depended partly on young birds being unfamiliar with the areas. More wide-ranging species might require much greater translocation distances. This could make the process uneconomic, and raise the question of whether there is any real benefit in moving individuals if a species is at carrying capacity in all areas where it might reasonably occur. At such a point, one might merely be moving problem-causing individuals around without conservation benefit. On the other hand, it seems eminently sensible to translocate harriers from areas where high density causes problems to areas not yet recolonised following extirpation (Watson & Thirgood 2001). This would compensate for the slow natural recolonisation by many raptor species that probably aided their initial extirpation.

Conditions of any discussions to consider removal of problem raptors should be the seeking of all possible alternatives to killing, and the promulgation by all parties of the view that extirpating raptors is totally unacceptable. Another desirable condition would be contribution of effort and resources to monitor impact on the affected populations, for example through mark-recapture estimates based on the live –trapping.

3.2.2- Zoning with quotas

Where predation is too diffuse for behavioural solutions or the removal of specific individuals, as in the case of harriers on grouse moors, the possibility of zoning with quotas has been discussed (Potts 1998, Watson & Thirgood 2001). The principle of zoning a protected species, into areas where protection remains absolute and other areas where licenses may be granted to remove animals, has been established for large carnivores in Spain and Scandinavia (J. Vinuela, W. Pratesi-Urquart, pers. comm.).
Zoning is a way or retaining management control in a situation where socio-economic pressures otherwise will result in illegal and unregulated management. One advantage of the approach is that it keeps those who might otherwise break the law, because they believe their security (livelihoods, safety) to be threatened, in a position for cooperation rather than conflict. The second substantial advantage is that the techniques can be regulated to ensure that they are humane, selective and low-impact.

The questionnaire survey of conservation authorities and hunting organizations in EU Members and Accession States (Fig 3) shows considerable agreement between the groups in the believed severity of (illegal) management of raptors. It also shows that the method considered most prevalent is shooting, with trapping and deliberate poisoning on average less prevalent. Only in Spain and the UK (where illegal killing was noted as a particular problem in WP3) plus Belgium and the Netherlands, was the severity of poisoning considered by Environment Ministry officials to be as great (scoring 2-3) as that of shooting or trapping. On the other hand, WP3 reported appreciable poisoning also in France, Greece, Portugal and Slovakia. The true extent of any illegal method is hard to quantify, and programmes such as ANTIDOTO in Spain suggest that poisoning is especially prone to under-estimation (J. Vinuela, pers. comm.). In contrast, traps are hard to conceal, so a low prevalence of trapping (Fig. 3) where there is conflict between hunters and other conservationists may be no coincidence. Yet live-trapping is more humane and selective than the other removal methods, and therefore the more desirable technique (Kenward 1987). For example, it can be used to restrict removal to juveniles, and not adults, of the target species. Moreover, because trapping is conspicuous, it is the most easily regulated approach.

Quota systems have been suggested as a means of preventing local extirpation. The principle would be that landowners are expected to be able to demonstrate an agreed minimum number

of breeding pairs (Potts 1998). However, quotas could be hard to enforce. An alternative that may be safer is to restrict removal methods to those unlikely to be totally effective, such as trapping (because some individuals will avoid traps), or permitting only juveniles to be killed or eggs to be removed. Where zoning is considered, pilot work is desirable to identify the removal technique that is most acceptable but with minimal impact. Such work must consider the possibility of areas with reduced protection acting as sinks for mobile individuals from other areas, which could be a particular risk for raptors. Removal thus requires continued monitoring at the start of widespread implementation.

3.2.3- Intra-guild predation

An approach that would avoid the removal of raptors by human, and hence of any need for derogations from protection legislation, is the encouragement of top-predators that may reduce the presence of a particular problem meso-predator species without having as great an impact on prey (Tapper 1999, Watson & Thirgood 2001). Thus, it is considered that the promotion of golden eagles (*Aquila chrysaetos*), which occur at much lower density than hen harriers on grouse moors, might reduce predation by harriers, as might fox predation on harrier nests (Watson & Thirgood 2001).

The possible value of this approach was demonstrated in North America, where predation by foxes on nesting ducks was reduced in areas with coyote (*Canis latrans*) predation on foxes (Sovada et al. 1995). The effectiveness of such an approach remains to be demonstrated as a management tool in Europe. However, it could also be useful for the two raptor species most cited as problems in Europe, goshawk and buzzard (Fig. 3). Both these meso-predators are popular prey for eagle owls (*Bubo bubo*) (Uttendörfer 1952, Mikkelson 1984). Moreover, buzzards space their nests to avoid proximity to goshawk nests (Kostrzewa 1991), and corvid nest densities are low near goshawk nests, with corresponding increased density of pigeons (Ellenberg 1983).

4- SOCIOLOGICAL MANAGEMENT TOOLS

4.1- Avoiding conflicts

Problems such as the dispute about management of raptors on grouse moors are sociological rather than ecological (WP5). Land-owners are constrained by concern that proposed ecological solutions, such as artificial feeding and habitat management, are at best not cost effective compared with removing harriers, and at worst not effective at all. Protectionists are concerned that such a compromise may lead to renewed extirpation of raptors over large areas, which would reduce biodiversity. Even if agreeable and enforceable quota systems could be established to avoid this risk (Potts 1998), protection organisations risk loss of membership if they sanction reduction of raptor density, not to mention the sacrifice of possible gains in income and status from campaigning.

In these circumstances, one approach (as currently applied on grouse moors) is prolonged discussion and associated research, until attitudes may change enough for compromise. Discussion needs to cover all the options in a situation, both for the types of hunting and for the ways of solving problems; otherwise, divergent interest groups will tend to focus on the issues "not open for discussion" and delay resolution. Similarly, research needs to evaluate the cost-effectiveness of all the solutions as well as possible implications for biodiversity. Aims should be to involve all stakeholders and build trust between them, as well as educating the supporters of the different groups so that those making compromises are not castigated (Workshop 2).

Parts of the process is for all parties to recognise the interests of others, and then to seek common ground (WP5). Gestures, such as permitting a solution that is difficult for one interest to accept, but only "on a temporary basis", should be considered very carefully as trust-building measures. It is important to realise that scientists too are stakeholders, because the interests of scientists can delay the settlement process. This is because it is the conflict, not the solution, that provides work for scientists

Nevertheless, long delay is undesirable if habitats and associated biodiversity are lost in the meantime. A better situation would be for general agreement that, where other ecological solutions are uneconomic, predators too may be treated as renewable resources (Kenward et al. 1991, Thirgood et al. 2000a). By analogy with conflicts between development and conservation, this approach might become more acceptable if compensatory offset arrangements could be agreed. Offset might be management agreement for other species, licence payments to fund other conservation work, or other innovations. For grouse moors, the offset of re-establishing harriers in other parts of the UK was offered (Potts 1998) but not accepted.

The need for a timely solution is important, and is where government should play an important role. This can be difficult, however. The "protect and reserve" paradigm has brought protectionist interests into conservation authorities, government scientists may benefit from the continuing dispute and the involvement of landowners can make the conflict attractive for "red-green" politicians. Convening through relatively neutral politicians, with a time frame defined by the terms of reference, may be the best solution.

An even better solution would be to promote education that renders potential conflicts rapidly soluble along pre-agreed lines. That process is already occurring, but is slow. There is a need of general acceptance for prioritising biodiversity over protecting the lives of individual creatures. With the death of individuals a necessary condition for biodiversity through trophic

webs and other recycling processes, all creatures (humans included) are renewable resources for other creatures. Unfortunately, the lack of understanding in urban societies that most wild animals naturally die traumatically and early in life is now reinforced by considerable vested interests in animal welfare organisations and in livelihoods obtained from protecting particular species. This works against the post-Rio emphasis on biodiversity.

It is a particular problem in the case of predators, especially avian predators, as an after-effect of previous management through extirpation and the subsequent problems with trophic accumulation of biocides. All conservationists, including hunters, need to understand this and to help develop the educational concepts and other tools to overcome misunderstandings about the natural world. Public education in its broadest sense, from pre-school through life and using all available media, will be needed to move that agenda forward.

Education that prevents conflicts between hunting and other conservation interests is important, not only because such conflict diverts public attention from biodiversity issues, but also because it wastes human resources within the conservation movement. Fortunately, the pragmatism of the WWF/IUCN large carnivore initiative is helping to build appreciation that individuals of the more charismatic large predators must sometimes by removed to protect livestock or even human lives (large carnivore refs). A context of possible direct threat to humans is highly educational.

In that context, it helps to have tools that make removal of predators less emotive. Words with strong connotations in human welfare, like "persecution", are best avoided and replaced by more precise terms, like "selective removal" of individual predators that cause problems. The term "culling" may be most appropriate when the aim is reduction of predator density. With a common goal for hunters and other conservationists to promote biodiversity, "extirpation" is no longer acceptable as a management technique.

4.2- Contributions from hunting

The subject of education bring us to the issue of managing human resources available from hunting. This is another area that can benefit greatly from good conceptual tools. How can hunters be encouraged to contribute maximally to conservation on a voluntary basis? Let us examine qualitative and quantitative aspects separately.

For conserving biodiversity, the ideal hunter would have minimal ecological impact and provide maximal resources for maintaining or improving biodiversity. Hunters who make large contributions for small bags more typically hunt mammal trophies than birds, with the shooting of large tetraonids as an exception. On the other hand, bird hunters often help preserve or restore habitats for species that are challenging to shoot. Contributions can be made as payments to landowners for access to habitats, or as taxes for conservation work or through voluntary work or funding. In North America, the tremendous success in restoring prairie wetland of "Ducks Unlimited" is being extended through "Grouse Unlimited" to over-grazed rangelands. In Europe, the pastures and deciduous woodland required by woodcock (*Scolopax rusticola*), for which a "left-and-right" double shot confers such prestige, are declining habitats too.

As the loss of gamebirds is so often due to loss of habitats needed by a wide range of species, the common interest of hunters and other conservationists in similar remedial actions against intensive land-use becomes very apparent. The need to reconcile gamebird hunting and biodiversity occurs mainly where hunters are ignorant of sound ecological principles and others

are ignorant that there is more to conservation than “protect and reserve”. Reconciling is a process of destroying that ignorance, and the onus tends to be on the hunters and those who manage hunting, to show that their actions are good for conservation.

A conceptual tool for encouraging conservation contributions from hunters is the Public Acceptance Rating Scale, on which an activity may be rated as "unacceptable", "tolerable", "useful" or "essential". The benefit of endeavours that move public perception of an activity such as hunting up the scale is reduced risk of adverse legislation. However, as well as the deterrent "stick" of unfavourable legislation, there is also scope for rewarding with "carrots". Hunters in Europe could be rewarded by other conservation groups with much more recognition than at present for their endeavours. In North America, after conservationists had celebrated de-listing the peregrine falcon from the Endangered Species legislation, falconers (who had helped to restore the species) were allowed licences for wild falcons again.

In terms of quality for conservation, falconers are an especially valuable group of hunters. After developing techniques in the "pesticide era" for domestic breeding of raptors, falconers in Europe now pay 300-1000 Euros for domestic bred raptors. In the UK, at least a thousand birds are sold annually, for a value much greater than is spent annually in the UK researching wild raptors. Is it better to pay for farmed raptors or to pay conservation levies for licensed birds from the wild? Goshawks, as well as being a problem at game release and feeding sites, are popular with falconers, so why not obtain levies from them for the trapped birds? Falconers have value for reintroduction work, ecological and veterinary research, wildlife rehabilitation and for demonstrations that educating the public about wildlife issues (Kenward 1987). Finally, falconry places relatively low demand on game resources, with one or two kills per person considered a very adequate bag for a day.

If hunters are to contribute maximally to maintenance and restoration of biodiversity, there need also to be adequate numbers. Where numbers fall, it may be worth looking at motivation for starting to hunt. Where this has been studied, social factors such as family and friends are shown to be important (WP 1). Courses and examinations are used in some European countries to enhance quality of hunters, but care should be taken not thereby to restrict numbers to levels of reduced utility for conservation.

Although hunting may originate socially, it is important to ensure that social aspects do not operate to the detriment of conservation. Hunting as a purely social pursuit can be highly demanding of resources, may deflect attention from conservation needs and can maintain an "us and them" attitude to other conservation interests that isolates from education and entrenches conflict. Hunting organisations and other conservation groups need to encourage hunters in directions that contribute most to biodiversity.

4.3- Conservation through sustainable use

Perhaps the most general and powerful sociological management tool is the concept of conservation through sustainable use of wild resources, as a replacement for the "protect and reserve" approach. This concept comes from the International Union for Conservation of Nature and Natural Resources, now known broadly as the World Conservation Union. IUCN was created in 1948, when government and non-government organisations combined to create an International Union for Protection of Nature. The organisation removed the emphasis on "protection" as early as 1956, with a change of name to the International Union for Conservation of Nature and Natural Resources. IUCN now brings together 79 states, 113 government agencies, 754 non-government organisations, 36 affiliates and some 10,000

scientists and experts from 181 countries. The union maintains a broad concept of conservation (Holdgate 1999), enshrined in its mission "to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable". By contrast, the main emphasis of many constituent non-governmental organisations continues to focus on protection of species and creation of reserves.

Since the mid 1980‘s, with the publication of the World Conservation Strategy, IUCN's emphasis has focused on developing knowledge of the social, economic and ecological conditions for sustainable development (Holdgate 1999). One product of this strategy was IUCN's Sustainable Use Initiative, which evolved from an appreciation that use of wild resources, whether consumptive (e.g. hunting, harvesting) or not (e.g. watching, wandering), could be important incentives to promote conservation. In 2000 a policy on sustainable use of wild living resources was overwhelmingly adopted by IUCN‘s members at their 2nd World Conservation Congress. This policy states that “ Use of wild living resources, if sustainable, is an important conservation tool because the social and economic benefits derived from such use provide incentives for people to conserve them”. The UNEP Convention on Bio-Diversity (CBD) signed in Rio de Janeiro in 1992 also embraced this principle, by recognising the conservation value of using "the components of biodiversity". IUCN is working with CBD Secretariat to develop broad “principles of sustainable use” that maintain and enhance biodiversity.

One great importance of changing emphasis from "protect and reserve" to "conservation through sustainable use" is that it provides a conceptual framework for different interests to work together. Protection of species and habitats is a part of conservation, providing insurance against extirpation and an educational sign that society values the species and habitats. However, more value for conservation can be obtained if people will pay to protect the species and to visit the reserves and associated education centres and tea-rooms. These people contribute to conservation through non-consumptive sustainable use of the species and habitats (though the human visitors should also be sustainably consumptive of other natural resources, such as water).

However, the finance available from non-consumptive sustainable use will have a limit. The most value for maintenance and restoration of biodiversity will come also from also tapping the human resources available from sustainable consumptive use. The crucial question is how to balance the different approaches to get optimal biodiversity from the resources available. This socio-economic question is addressed in the final section.

5- ECONOMIC MANAGEMENT TOOLS

5.1- Compensation

Statutory bodies may consider paying compensation, for example to farmers that have livestock killed by eagles (Davies 1999). Compensation seems not yet to have been paid to compensate for loss of income from hunting. However, loss of income is notoriously difficult to quantify, so it is probably better that any compensation should be for positive outputs, which are much easier to confirm. For example, payments might be for releasing additional game. An even better approach may be to pay for numbers of successful raptor nests, because such payments can then be seen as a reward for looking after the predators.

However, it is important that statutory compensation payments, and the checks necessary to validate claims, should not drain conservation resources without a net gain for biodiversity. This may make the approach most suitable for landowners who are hosts for rare species. In Spain, for example, the conservation movement is seeking measures whereby less tax might be paid on land with nests of the endangered imperial eagle (*Aquila adalberti*).

A major question when considering compensation is "who will pay?" One possibility comes from the new emphasis of the EU Common Agricultural Policy for the period 2000-06 on conservation of natural resources and on rural development through Agenda 2000 (Agriculture Directorate-General 1999, 2000, OECD 2001). Agenda 2000 includes special agri-environmental measures, of contractual payments to landowners for commitments going beyond good agricultural practice. However, it is important to remember that CAP subsidies come from taxes collected by democratic governments, which face pressures (a) to minimise taxes and (b) to devote what taxes they collect to fund security, education, health and transport systems. Elements of a CAP that are devoted to conservation may therefore be vulnerable to competition from more powerful lobbies and not be sustainable (Kenward & García Cidad 2002).

Of course, compensation for raptor predation can also be indirect. For example, income from eco-tourism might be sought at sites where predation is conspicuous in small areas, such as at game bird release pens. Another consideration is that raptors may themselves compensate for occasional killing of game or livestock by suppressing numbers of other competitors or predators. An example is the predation by black eagles (*Aquila verauxii*) on rock hyrax (*Procavia capensis*) in South Africa. Although the eagles occasionally kill lambs (Davies 1999), they can also reduce hyrax populations, which compete with livestock for food (Davies 2000).

For some species, compensation could also be obtained by tapping sustainable-use resources. Landowners might view nests of goshawks or peregrine falcons very differently if they received payment for transferring young to falconers (Kenward 1987). With market prices close to 750 Euros for birds from domestic breeding, an average brood size often close to 3 (Cramp & Simmons 1980) and a requirement to leave one chick in the nest, it could be hard for statutory compensation to compare with a value of 1500 Euros for a successful nest. Statutory compensation could be reserved for species without such strong value as a resource.

5.2- Economics of sustainable use

A very healthy development in the debate about raptors on grouse moors has been the estimating of economic costs for different approaches (Thirgood et al. 2000a). Owners, whether individuals or communities, tend to seek optimal value from their land. Thus, optimisation of biodiversity becomes an economic issue. A convenient measure for land-use is annual income, although other measures such as employment potential or generation of other public or private goods may also be applied.

The European Sustainable Use Specialist Group of IUCN has developed a project that provides a conceptual tool for addressing biodiversity issues in a multi-use countryside, and could if funded produce practical tools. The project, Sustainable Action for Fauna and Flora in the Regions of Europe (SAFFIRE), proposes a framework of economic tools for researching and then implementing the conservation of biodiversity through sustainable use (Kenward & García Cidad 2000). The aim is to produce situations where income from use of wild resources (***U***) that is enabled by constrained land-use (giving income ***C***) can be more profitable than from intensive land-use (***I***), in other words:
$$U + C > I$$

One major aim of SAFFIRE is to discover, by survey and GIS-based modelling, how much land might have its biodiversity enhanced at present by funding from individuals and local communities on the "user-pays" principle. A second major aim is to elucidate socio-economic factors that can maintain and enhance funding from these local sources, because of recent worrying declines in non-consumptive sustainable uses. For example, US surveys have detected a 17% decline during the last decade in people watching wildlife, although numbers hunting and fishing in the USA have remained stable (USDI & USDC 1996). In Europe too, the British Trust for Ornithology has a worrying low recruitment of young members for its volunteer activities (BTO 1999). Is watching wildlife becoming too tame for young people, compared with television and computer games, whereas the hands-on aspects of hunting and fishing are more appealing? On the other hand, is social pressure against hunting reducing the value of this resource? Recruitment of young hunters too may be low in some countries (WP1).

This whole field of conservation socio-economics is very much in its infancy. As far as we know, no attempts have been made to evaluate relationships between ***U***, ***C*** and ***I*** although data are available in a number of studies that can be used. For example, the reduction in cereal crop yields (=[***I-C***]/***I***) has been estimated when headland-edges are left unsprayed, which increases abundance of game birds and other wild fauna and flora (Boatman & Sotherton 1988, Sotherton 1991).

As approaches like SAFFIRE develop, a huge and highly innovative effort will be needed to optimise conservation from sustainable use. At local level, supplies of funding will differ according to local wealth and attitudes, land suitability for different uses, alternative attractions for tourists (e.g. heritage), distance from towns and other factors. There is a large diversity of uses of wildlife beyond bird-hunting, including hiking, horse-riding, wildlife watching, flower-picking, fruit and fungi collecting, photography, fishing, falconry and many others. Optimal use of funding will need to trade the demand for different uses against economic costs and gains in biodiversity, derived from relationships between biodiversity, ***C*** and all types of ***U***.

The trading of all these demands, and the huge quantities of ecological data needed to manage biodiversity, will require extremely sophisticated decisions that can best be made with the aid of modelling and predictive software. Those decisions need to be made at local level, so that communities can both decide how their environment is managed and monitor that management. The internet now provides the opportunity to deliver the necessary decision support to local level. On this basis, the partners of REGHAB have joined with members of IUCN's European Sustainable Use Specialist Group to apply for funding under Framework 6 to establish a Network of Excellence that builds Decision Support in Rural Economies of Europe (DESIRE). The intention is not only to implement SAFFIRE throughout the EU and Accession States, but also to pilot an Intelligent Management and Geographic Information Network (IMAGINE) in 5 European countries.

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6- CONCLUSIONS

Conservation of biodiversity in Europe still means, for many people, the protection of species and habitats (in some countries, a word for conservation is scarcely used). The emphasis on "protect and reserve" is a response to several factors, including historic over-hunting of some species and management of predators through extirpation, perceptions of hunters as elitist, romanticising of "nature" and growth of a nature protection industry. Protection legislation has been useful as an educational tool, for signalling that society views loss of biodiversity through extirpation of species as unacceptable, and for drawing attention to the needs of rare species. However, rigid protection tends to hinder the application of human resources from hunting to maintain or promote biodiversity, to promote conflicts that waste human resources without benefiting biodiversity and to result in illegal predator management that reduces biodiversity.

Management tools are needed at several levels to maximise benefit for biodiversity from hunting. The tools may be ecological, sociological and economic. At one level, tools are needed to reduce problems for hunters (and other groups) from predators. These tools can include behavioural methods to reduce losses of huntable birds by excluding or deterring predators, habitat management, distracting predators with artificial feeding and hunting that pre-empts predation. Encouragement of top-predators to reduce numbers of meso-predators may also be worth considering. Such tools are essentially ecological and avoid conflicts with protection interests.

Where these techniques are inadequate, the conceptual tool of treating predators as a renewable resource is a sociological approach, to facilitate negotiation about removal of individual predators that cause localised problems, or even culling to reduce density of predators responsible for severe but diffuse impacts. If removal is sanctioned, all parties should first examine non-lethal alternatives, such as compensation, provision for falconry or translocation, especially for predators with restricted distributions. All parties should also agree that extirpation of predators is unacceptable and to use only selective and humane methods that cannot easily extirpate predators locally (e.g. live-trapping, egg removal), or will leave a quota, with zoning to minimise the area in which removal is permitted. Sanction of culling might be made dependent on agreement for offset land management to benefit biodiversity.

Another level of tools is available to maximise benefits from hunting. This approach aims initially to improve the quality of benefits for biodiversity from hunters and hunting, through education and through encouraging approval from other conservation interests groups for positive contributions, as well as the judicious application of deterrents for poor behaviour. It may be worth encouraging types of hunting that can be especially beneficial. Falconry, for example, develops techniques to breed and re-introduce rare raptors, has low exploitation impact on huntable bird species without requiring high densities and could provide payments to compensate landowners for raptor nests.

A final level of sociological tool should help to avoid resource-diverting conflicts, by encouraging cooperation between hunting and other conservation interests. A concept that consumptive and non-consumptive sustainable use of the components of biodiversity should pay for conservation, developed by IUCN and incorporated in CBD, can replace protect-and-reserve conservation. Engaging all interests through a "user-pays" principle provides a pragmatic basis for conservation of multi-use countrysides.

In Europe especially, more work is needed on socio-economic tools to aid biodiversity in Europe through hunting. Tools to help resolve conflicts are sometimes necessary, but tools to

prevent conflicts and to maximise conservation benefits from hunting may be more important. Convergent use of all available human resources, by maintaining diverse sustainable uses of wildlife resources, may prove the best way to preserve a diversity of wildlife and wild places.

Those with interests in REGHAB stand to benefit from the new socio-economic approach of conservation through sustainable use. Scientists will benefit because the knowledge needed to plan conservation by sustainable use requires far greater ecological and socio-economic research than has been necessary for a protect-and-reserve strategy. Landowners should benefit from new sources of income. Those genuinely interested in biodiversity should be glad of improved resources for it. Hunters should be pleased to be re-integrated into the conservation movement. Indeed, the process of reconciling all the different interests, in ways that optimise biodiversity in multi-use countrysides, should induce the pragmatism that relegates conflicts about bird hunting to a footnote in history

7- RECOMMENDATIONS

- To refine ecological management tools for resolving conflicts between hunters and predators.
- Where possible, to use behavioural or fiscal techniques to reduce predation without removing predators.
- Only to permit removal of predators where lack of cost effective alternatives puts biodiversity at risk.
- To ensure that any removal is selective, humane, preferably non-lethal and cannot cause extirpation.
- To seek biodiversity gain by using removed predators to restock elsewhere or raise conservation income.
- To develop socio-economic tools to resolve conflicts between hunting and other conservation interests.
- To seek to maximise benefits from sustainable hunting for maintenance and enhancement of biodiversity.
- To encourage a "user-pays" approach to converge all human resources that can benefit biodiversity.

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